Gender differences in the effect of acute psychosocial stress on emotional recognition

By Laura Ward

Supervised by: Dr. Maria Cordero **April 2018**

Gender differences in the effect of acute psychosocial stress on emotional recognition

ABSTRACT

Emotional recognition (ER) is an important component of social interaction and based on inference, facilitates decision making. Research based on emotional recognition has been extensive and recent studies have included the effect of adverse psychological states on ER, particularly psychosocial stress. Such studies have excluded the female population which has led to a limit in generalising results. The present study aimed to investigate the effect of acute social stress on ER between genders in individuals participating in higher education. Through experimental design 37 participants were recruited using opportunity sampling. Participants took part in two emotional recognition tasks one in a relax condition and one in a stress condition. Stress was induced though a task with time/performance and peer comparison elements. Emotional recognition was assessed by calculating correct responses during each task. Stress was measured subjectively and through the physiological measure of electro-dermal activity during the experiment. No significant difference was found in the effect of stress on emotional recognition between genders. However, a strong tendency towards significance was implicated in a main effect of gender on ER, consistent with previous research. Future research needs to consider gender differences in the effect of stress on recognition of individual emotions.

KEY WORDS:	EMOTIONAL RECOGNITION	SEX	ELECTRO-DERMAL ACTIVITY	STRESS

Introduction

Emotional recognition is a fundamental non-verbal element of social interaction, enabling the viewer to infer thoughts, intention and emotional state of others to facilitate decision-making (Attwood et al., 2017; Bechara et al., 2000). Considered as a main component of social cognition, emotional recognition is an ability to accurately perceive emotions (Cusi et al, 2012). Basic emotions that have been identified to be most reliably recognized from facial expressions are happiness, surprise, fear, anger, disgust and sadness (Adolphs, 2002).

Attentional bias towards facial expression recognition differs in individuals depending on psychological state and functioning (Gotlib et al., 2004; Bradley et al., 2000). This can lead to negative outputs of behaviour based on a misinterpretation of emotional expressions. For example: individuals with depression have been found to show a bias towards sad faces and those with high trait anxiety to show a bias towards angry faces (Gotlib et al., 2004; Bradley et al., 2000). This is suggestive that we perceive environmental stimuli as congruent to our current emotional state. Traumatic brain injury (TBI) has also found to impair the accurate recognition of emotion; this has enabled localisation of facial recognition (Neumann et al., 2015). The brain areas underlying the basic processes of facial recognition have been identified as the anterior cingulate cortex, the ventromedial prefrontal cortex and the amygdala (Adolphs, 2002). Interestingly, these brain areas are also targeted during a stress response (Dedovic et al., 2009).

Stress may alter the processes underlying social cognition as well as human attentional, response mechanisms and perception (Staal, 2004). Recently studies have depicted that humans may react differently when confronted to social stress, such as an increase in prosocial behaviour (Von Dawans et al, 2012). Defined as moderate stress, psychosocial stress has been commonly used in studies to increase validity as it is a reflection of what humans encounter on a daily basis (Corbett et al, 2017). A study that utilised the Tier social stress test (TSST), a task that includes an anticipatory period, a public speaking task and a mental arithmetic task, found participants demonstrated increased perceptual attention to angry faces, over happy or neutral faces (Wieser et al, 2010). Although this conflicts with the findings that social stress can elicit pro social behaviour, the methodology described is subject to certain limitations. Whilst presented with facial expressions participants were instructed to simply view the pictures, results were generated from simultaneous EEG recordings and then a scale of emotional arousal rated after viewing expressions. This is restricted to internal psychological state rather than behaviour, which can be accessed via emotional recognition.

Research that has investigated emotional recognition and social stress has aimed to provide further insight into emotional perception (Chen et al, 2013; Daudelin-Peltier et al, 2017). Studies on the effect of stress on emotional recognition in boys and men found no significant difference on accurate identification between control and stress groups (Chen et al, 2013; Daudelin-Peltier et al, 2017). In a stress group consisting of 20 boys, in the continua of angry-fearful faces, the emotion of fear was more likely to be identified (Chen et al, 2013). In adult males a study that used expressions from Karolinska directed emotional faces database (Lundqivist et al.1998) found the recognition of disgust was significantly decreased and sensitivity to surprise was significantly increased under stress (Daudelin- Peltier et al,2017). Previous studies on the effect of stress on ER have used independent groups, one as a control and one that takes part in the stressor; this design is subject to individual difference effects in that groups may differ in emotional recognition capabilities or stress sensitivity. Despite this, findings described in healthy participants play an important role in identifying adaptive coping mechanisms in response to stress that could be applied to treating perception sensitivity in maltreated children and adults with anxiety.

In addition, literature discussed on the effect of social stress on emotional recognition uses male participants only; excluding this extraneous variable has been based on heavily reported gender differences in emotional recognition (Hampson et al, 2006; Ietswaart et al, 2008; Collignon et al, 2010; Snowdon et al, 2013; Wright et al, 2017). A recent study investigating sex differences in facial expression processing using video stimuli (FEP), Wingenbach and colleagues (2018) concluded that females have an advantage over males in FEP. Drawing on this research has sought to find an explanation for this difference using the Levels of Emotional Awareness Scale (LEAS) measuring individual differences in emotional awareness or emotion concept learning (Wright et al, 2017). As the relationship between emotional recognition accuracy and sex was found to be mediated by individual differences in LEAS scores, it has been concluded that sex differences could be explained by differences in emotional awareness. Emotional awareness is a trait derived from early learning so could be susceptible to adaption in adverse conditions such as acute social stress. Although sex differences in emotional recognition seem to be established, excluding females from the effect of stress on emotional recognition has led to bias results that can't be generalised as the female population is excluded.

So as sex differences have been found in emotional recognition, can this be transferred to the effect of psychosocial stress, considering both are affiliated with the same area of the brain (Adolphs, 2002; Dedovic et al, 2009)? Current studies have reported sex differences in overall behavioural or physiological responsiveness to psychosocial stress (e.g. Gonzalez-Liencres et al. 2016; Stroud et al. 2002;Taylor et al, 2000). Within the ventromedial prefrontal cortex, an area associated with emotional processing and stress, sex differences have been found in the pattern of left-right asymmetry (Imig et al, 2000;Tranel et al. 2005). Enhancement of memory by emotion in the amygdala has also been reported to be restricted to the right side in men and the left in women (Cahill et al, 2004). This suggests that men and women may use different strategies in problems that require the discussed brain areas, which could influence differences in behavioural outputs. Moreover, sex differences have been documented in ER of individual emotions in TBI, women were significantly better than men at identifying fearful expressions (Zupan et al, 2017).

In a review of sex differences in physiological response to acute psychosocial stress it was reported that women usually show lower hypothalamic-pituitary-adrenal axis (HPAA) response to acute psychosocial stress compared to men (Kajantie and Phillips, 2006). The HPAA is the primary physiological mechanism underlying stress reactivity (Gotlib et al, 2008). Stephens and colleagues (2016) also found sex differences in stress response to the TSST; following the social stressor women had lower levels of adrenocorticotropic hormone and cortisol levels compared to men. As well as sex differences in physiological measures, behavioural differences in response to psychosocial stress have also been documented; after taking part in social stressors females were found to be more generous and cooperative than males but, unlike males, no significant effect of stress was found in prosocial risk taking tasks (Nickels et al, 2017). Moreover, sex differences may also be found in the effect of stress on emotional recognition. It has been articulated that, under stress conditions, false positive errors can result from the automatic processing of the amygdala relating to potentially threatening signals from the environment (Fernandez et al, 2009). From an evolutionary standpoint, men have been found to attend to threatening signals more over women therefore at greater risk of false positive errors (Sulikowski and Burke, 2012). Threatening signals and signals that could indicate threat could include facial expressions such as anger, fear and surprise.

Aims and Objectives

The research aims to investigate the effect social stress on ER of students in higher education, specifically gender differences in the effect of social stress on emotional recognition.

The objectives are to test emotional recognition accuracy through a facial expression recognition task; to induce stress through task that is timed and subject to peer comparison; to measure participants' levels of stress throughout the experiment using physiological measures of electro-dermal activity (EDA) as well as subjectivity through a self report likert scale. The analysis will focus on emotional recognition accuracy after a relax condition and after a stress condition. The data from the facial expression recognition task will be analysed in relation to gender.

Hypothesis

In the present study it is hypothesised that a gender difference will be found in the effect of social stress on emotional recognition.

Method

Design

This quantitative experiment used within repeated measures ANOVA design. Factor 1 being gender with two levels: male and female and factor 2 being condition with two levels: accuracy of emotional recognition after relax and accuracy of emotional recognition after stress. Measures were taken to ensure stress was induced during the experiment.

Participants

An inclusion criterion for participants was that they were in higher education, selected to control the level of emotional intelligence which could have an effect on accuracy of emotional recognition. There was an age limitation, 19-25,due to evidence for a correlation between age and emotional intelligence (Cabello et al, 2016). Exclusion criteria limited participants to those who did not suffer with anxiety disorder due to induced stress, which may have caused anxiety.

Participant (N=41) consisting of 21 males and 20 females aged 19 to 25 years old (*M*=21.62;*SD*=2.215) were recruited through opportunity sampling advertised on the UK univsersity participation pool. An incentive being 90 participation points awarded for taking part (Appendix 1).

Outliers found in the data led to exclusion of 4 participants, two were excluded as they were already familiar with the procedure to induce stress and two were excluded due to interruptions during the experiment.

This study followed the BPS code of ethics (BPS, 2010) and was approved by the ethical board at MMU (Appendix 2).

Materials, Apparatus and Measures

Subjective measures and physiological measures were taken from participants whilst completing emotional recognition task and Montreal imaging stress task (MIST); these are outlined below.

The Montreal Imaging Stress Test (MIST) Based task

The MIST is derived from the Trier Mental Challenge Test and consists of a series of computerised mental arithmetic challenges combined with social comparison components (Dedovic et al., 2005). The present study uses Psychopy, software for cognitive experiments, to run the MIST utisilising a keyboard and mouse for participant response (Peirce, 2007; Peirce, 2008). Participants taking part in the MIST task complete a series of simple mental arithmetic questions, each one within a short time limit (3-4 seconds) that is indicated bar a bar at the top of the screen. Participants are asked to answer by pressing the number keys at the top of the keyboard and immediate feedback is shown ‘correct’, ‘incorrect’ or ‘timeout’. The social comparison is displayed by a bar at the top with an arrow indicating where the participant is scoring in relation to peers, e.g. if the arrow is in the red the score is below peers. (Appendix 3).

Emotional recognition task (ERT)

The ERT measured accuracy of facial expression recognition using 12 ambiguous micro expressions from Spontaneous Micro- Facial Movement Dataset (see signed agreement; appendix 4), SAMM (Davison et al. 2017) and 12 unambiguous facial expressions from the The Karolinska Directed Emotional Faces (Lundqivist et al.1998). Each video showing a display of each facial expression lasts 10 seconds, following each expression the six emotions are displayed on the screen, happy, sad, disgust, angry, surprise and fear (see appendix 5). The participant selects which emotion they think is the closest match to the expression displayed and then the next video plays.

Measurement of stress

a) *Physiological measure*

Physiological data was gathered for the duration of the experiment with specific focus on the measurements during relaxation and the MIST task. This was measured using the Biopac-MP45, which was connected to a laptop, and analysed using the Biopac student lab 4.0. An image of the results was displayed on the laptop as a polygraph (see Appendix 6). Electro dermal activity (EDA) is indicated on the graph in red, channel 1. To indicate different phases of the experiment markers 1-5 were used, 1-2 for rest, 4-5 for MIST and 3 for a break. To create an average EDA measure at rest and during the MIST task, the mean data was taken between these markers.

Electro-dermal activity (EDA)

To record EDA a pair of 11mm contact Ag-AgCl disposable electrodes (Biopac EL507) filled with isotonic gel were used (0.5% saline in neutral base, Biopac GEL 101).

The index and ring finger on the non- dominant hand were cleaned using an abrasive pad, extra isotonic recording gel was placed on the fingers and the electrodes were then secured using medical tape. For signal transformation, the SS57L transducer connected the electrodes to the MP45.

b) *Subjectivity measure*

To gain a subjective measure of changes in stress, participants were asked throughout the experiment to indicate on a likert scale, 5 being very stressed to 1 being not stressed at all, how stressed they were (Appendix 7). Specifically, participants were asked to indicate stress before the experiment (a basal measure), after relaxation, after the MIST task, after a break and after both emotional recognition tasks.

Procedure

The experiment adhered to British Psychological Society (BPS) and MMU's code of ethical guidelines (see appendix 2). Participants received full information before taking part in the study (Appendix 8). Following this, participants read and signed a consent form (Appendix 9). Participants were reminded of the right to withdraw at any point without reason.

An introduction to the experiment was read from a script to the participant, explaining that skin conductance and pulse would be recorded to measure physiological arousal and that it is completely harmless. The electrodes were then placed on the non-dominant hand and were asked to rest this on the table facing up and to try not to move it during the experiment. Two minutes was taken for calibration and participant was asked to indicate a basal psychological stress level.

The participant then took part in either condition A or condition B.

Condition A: Participants were asked to relax for 2 minutes (task 1) by taking deep breathes in and out, followed by the facial emotional recognition task (task 2). On completing the first emotional recognition task participants then had a 5 minute break (task 3) and were offered an article with neutral content to read. After the break participants took part in the MIST task for 2 minutes (task 4) followed by the second emotional recognition task (task 5).

Condition B: Participants took part in the MIST task for 2 minutes (task 4) followed by the facial emotional recognition task (task 5). On completing the first emotional recognition task participants then had a 5 minute break (task 3) and were offered an article with neutral content to read. After the break participants were asked to relax for two minutes (task 1) by taking deep breathes in and out, followed by the second facial emotional recognition task (task 2).

Before completing the MIST task computerised instructions were presented to the participants (Appendix 10). EDA and PR were measured throughout the experiment. During the experiment participants were asked to indicate stress on a 5 point questionnaire on psychological stress 1= not very stressed and 5= very stressed (Appendix 7). This was laid out next to the mouse and participants were asked to complete it after relaxation, break, MIST and both emotional recognition tasks.

On completion of the experiment the participant was thanked for taking part and given a full debrief (Appendix 11). Each participant was asked to generate an anonymous code to protect anonymity. The debrief fully revealed the aims of the study and that data would not be kept from the MIST task, it was only to induce social stress. Participant pool points were awarded within 72 hours.

Data Analysis

Raw data entered into IMB® Statistical Package for the Social Science 23.0 (SPSS) for Windows and then analysed using an ANOVA repeated measures design. Emotional recognition accuracy was calculated by adding up the correctly identified emotions on the emotional recognition task, in total, after the relaxation task and after the MIST task.

Average EDA and HR for during relaxation and during MIST task were calculated using Biopac student lab 4.0 and transferred into SPSS for analysis.

Results

Descriptive Statistics

Descriptive statistics were created for all measures of stress during: relaxation, emotional recognition task after relaxation, the MIST task and emotional recognition task after MIST based task including subjective scores and average EDA and HR. Descriptive data was also produced for male and female emotional recognition accuracy in total, after relaxation and after MIST task. Table 1 shows the mean and standard deviation scores

Table 1.

Mean (M) and Standard deviations (SD) subjective stress after relaxation MIST task and emotional recognition tasks, EDA and HR averages during relaxation, MIST based task and emotional recognition tasks, Emotional recognition accuracy in total, after relaxation and after MIST (N=37)

	M	*SD*
Subjective stress after relaxation	1.54	0.77
Subjective stress after emotional recognition task (relax)	1.89	0.77
Subjective stress after MIST	4.27	0.51
Subjective stress after Emotional recognition task (stress)	2.97	0.87
EDA average during Relaxation	11.42	6.83
EDA average during emotional recognition task (relax)	11.94	6.99
EDA average during MIST	14.59	7.31

EDA average during emotional recognition task (stress)	13.63	6.83
Total number of accurately Identified ambiguous emotions	6.30	2.159
Total number of accurately identified ambiguous emotions after relaxation	3.08	1.320
Total number of accurately Identified ambiguous emotions after MIST	2.95	1.177
Total number of accurately Identified unambiguous emotions	16.68	2.186
Total number of accurately identified unambiguous emotions after relaxation	8.32	1.334
Total number of accurately identified unambiguous emotions after MIST	8.46	1.216
Total number of accurately identified emotions	22.81	2.72
Total number of accurately identified emotions after relaxation	11.57	1.64
Total number of accurately identified emotions after MIST	11.30	1.60

Inferential statistics

A paired t test was applied to assess the effectiveness of the MIST task in inducing stress, measured by subjective ratings, EDA and HR. A Shapiro-Wilk test was ran for normality and most variables were above $p>0.05$.

Table 2.

Paired sample t test scores of stress at relaxation and during MIST task (N=37)

	Relaxation mean score	MIST mean score	T	P
Subjective Stress	1.54	4.27	13.81	<0.001
Average EDA	11.42	14.59	-9.52	<0.001
Average HR	132.89	84.58	-16.27	<0.001

The results from table 2 show the scores from subjective stress, average EDA and average PR were significantly increased during the MIST task from relaxation(p<0.001).

Table 3.

Paired sample t test scores of stress during emotional recognition tasks after relaxation and MIST (N=37)

	ER task (relax) mean score	ER task (stress) mean score	T	P
Subjective Stress	1.89	2.97	-6.18	<0.001
Average EDA	11.94	13.63	-6.31	<0.001

The results from table 3 show the scores from subjective stress and average EDA were significantly increased in the emotional recognition task following MIST from the emotional recognition task following relaxation (p<0.05).

The results from table 2 show the scores from subjective stress, average EDA and average PR were significantly increased during the MIST task from relaxation(p<0.001).

The results from table 3 show the scores from subjective stress and average EDA were significantly increased in the emotional recognition task following MIST from the emotional recognition task following relaxation (p<0.05).

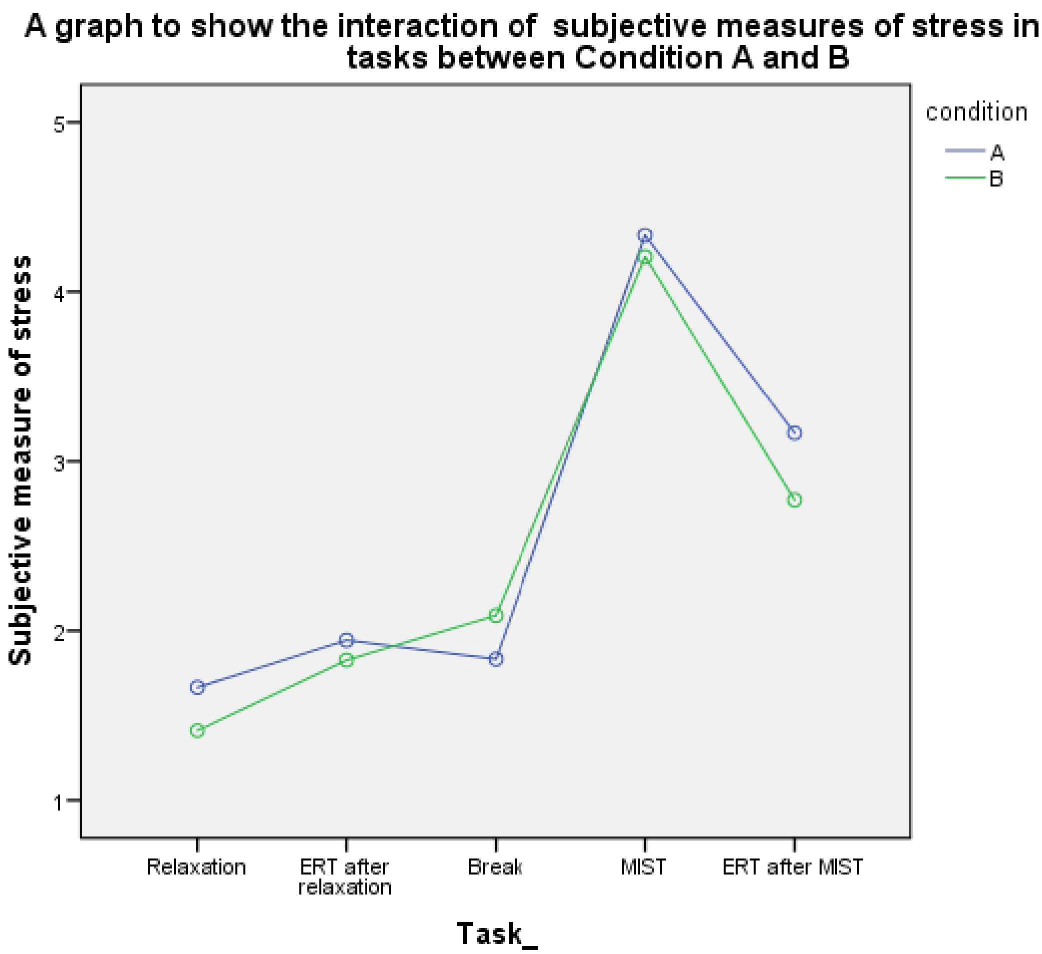
A two- way repeated measures ANOVA was also ran to determine the interaction between each measures of stress, EDA and subjective stress, gender and condition (A & B) within participants. The mean measure of stress was calculated for each measure at five tasks throughout the experiment: relaxation, emotional recognition task after relaxation, break, MIST and emotional recognition task after MIST.

Subjective stress

Mauchly's test of sphericity indicated that the assumption of sphericity was met for the two- way interaction $\chi^2(9)$= 14.672, p=.101. There was no statistically significant two-way interaction between subjective stress measures and condition, *F* (4, 132) = 1.297, *p*=.275. Also, there was no significant main effect of condition: participants taking part in condition A (*M*=2.589) did not rate stress as significantly higher than those taking part in condition B (*M*=2.461), *F*(1, 33)= .677, *p*=416.

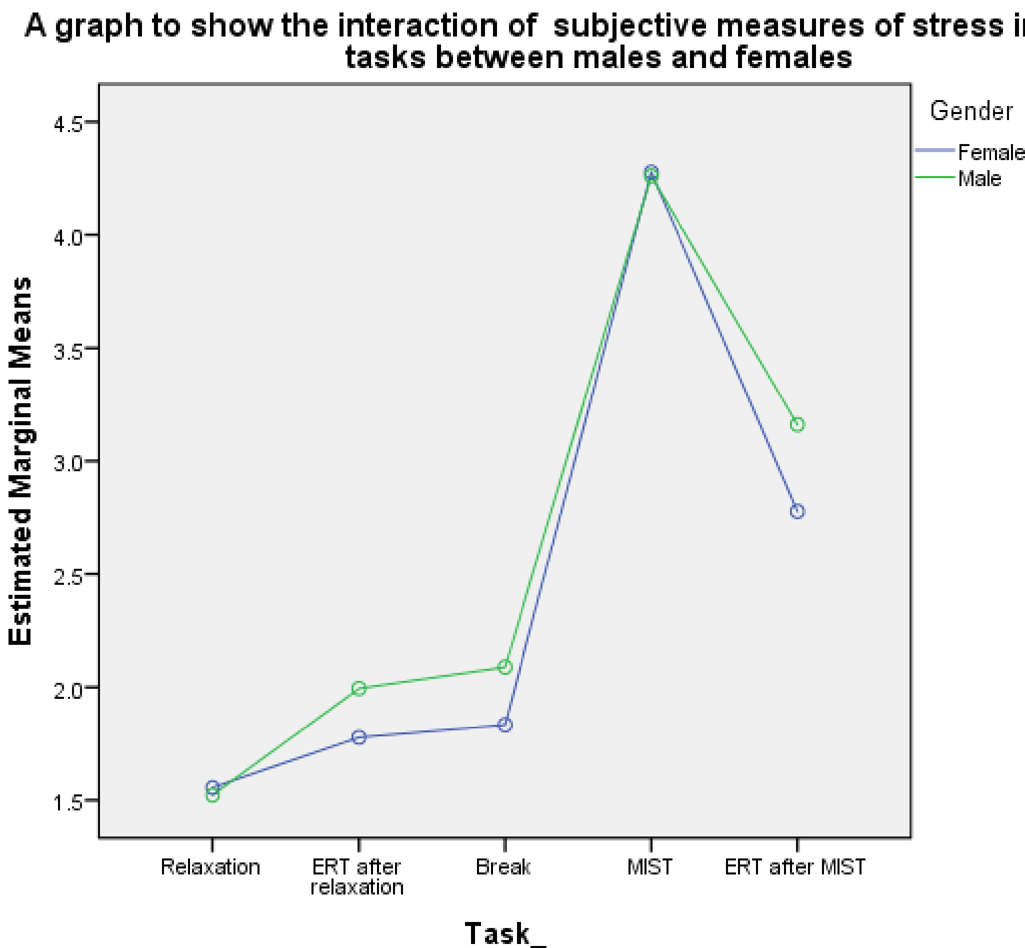
This is demonstrated in fig. 1

Graph 1.



There was no statistically significant two- way interaction between subjective stress measures and gender, *F* (4, 132) = .723, *p*=.578. Additionally, there was no main effect of gender: females (*M*=2.444) did not rate stress significantly higher than males (*M*=2.606), *F*(1,33)= 1.077, *p*= 307.This is demonstrated in fig. 2

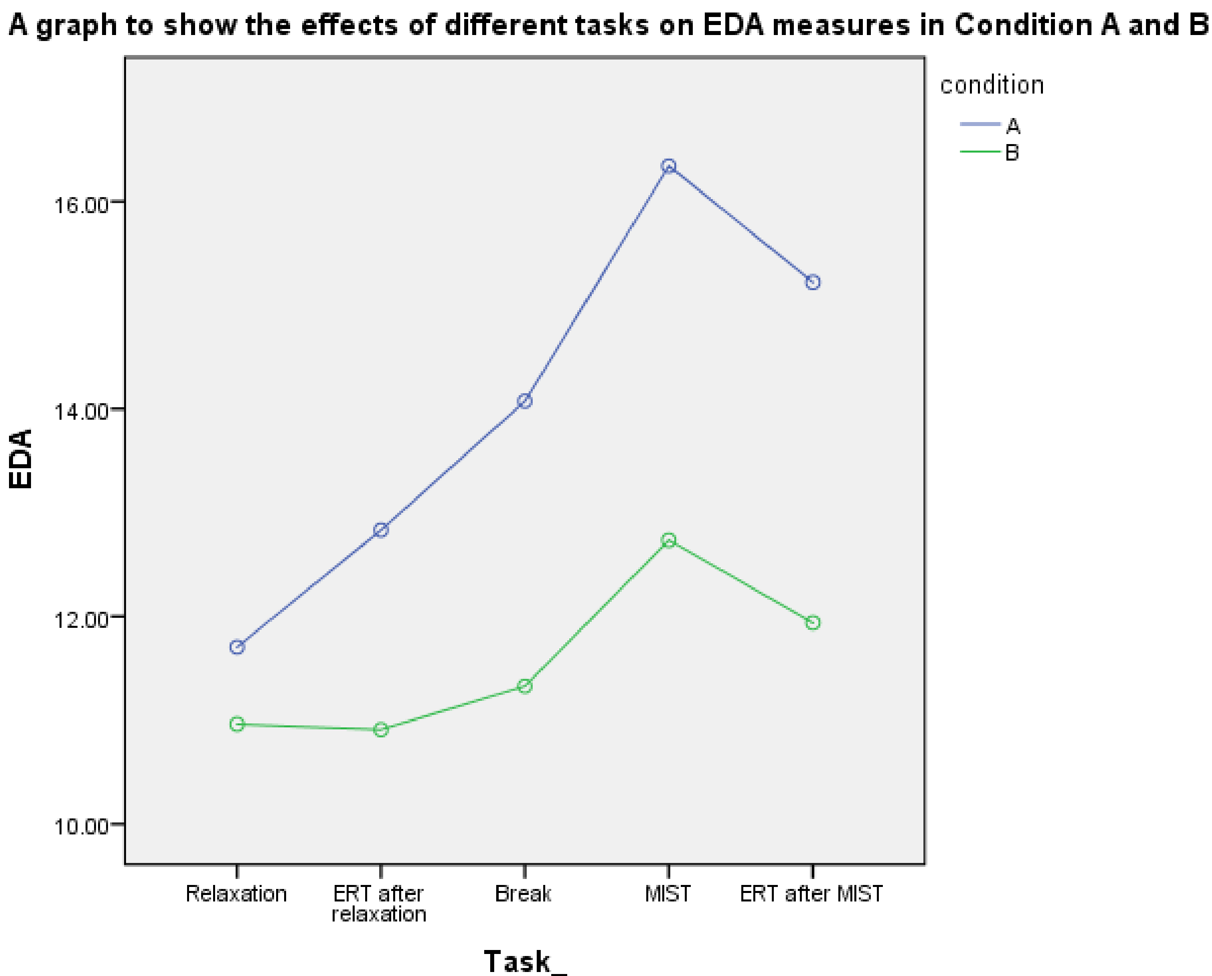
Fig. 2



There was a main effect of task on subjective measures of stress: task 1, (*M*=1.539), 95% CI [1.284 to 1.793], task 2 (*M*=1.886), 95% CI [1.625 to 2.147], task 3 (*M*=1.961), 95% CI [1.698 to 2.224], task 4 (*M*=4.269), 95% CI [4.097 to 4.442] and task 5 (*M*=2.969), 95% CI [2.686 to 3.252], F (4, 132)= 109.245, $p<0.001$. All pairwise comparisons of subjective stress measures in tasks were significant, $p<0.001$ except task 1 and 2, $p=.275$, task 1 and 3, $p=.162$ and task 2 and 3, $p=1.000$.

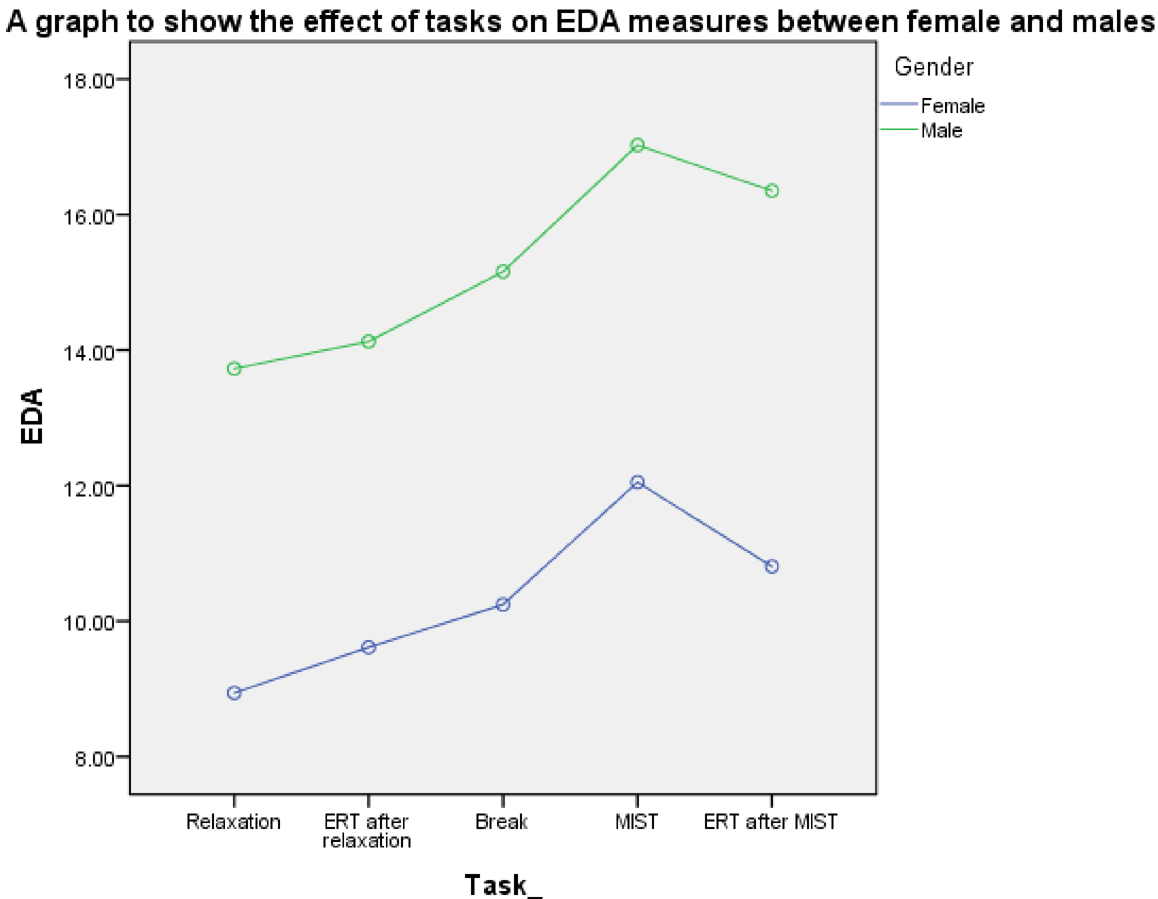
EDA
Mauchly's test of sphericity indicated that the assumption of sphericity was met for the two- way interaction $\chi^2(9)= 16.109$, p=.065. There was a statistically significant two – way interaction between EDA measures and condition, $F\ (4, 132) = 13.077$, $p < .001$. Post hoc test revealed mean EDA measure was 2.46, 95% CI [-1.926 to 6.846] higher in condition A compared to condition B, a difference that was not statistically significant, $F\ (1,33)= 1.301$, $p = .262$. This is demonstrated in fig. 3

Fig. 3



There was no statistically significant two-way interaction between EDA measures and gender, *F* (4,132) = 1.412, *p*= .233. However, mean EDA measure was 4.946, 95% CI [.560 to 9.332] higher in males compared to females, a difference that was statistically significant, *F* (1,33)= 5.264, *p*=0.028. This is demonstrated in fig. 4

Graph 4.



There was a main effect of task on EDA measures of stress: task 1, (*M*=11.334), 95% CI [9.149 to 13.518], task 2 (*M*=11.871), 95% CI [9.636 to 14.106], task 3 (*M*=12.701), 95% CI [10.434 to 14.969], task 4 (*M*=14.538), 95% CI [12.248 to 16.828] and task 5 (*M*=13.580), 95% CI [11.504 to 15.656], *F* (4, 132)= 65.556, *p*<0.001. All pairwise comparisons of subjective stress measures in tasks were significant, *p*<0.001 except task 1 and 2, *p*=.124.

Emotional recognition

Repeated measures

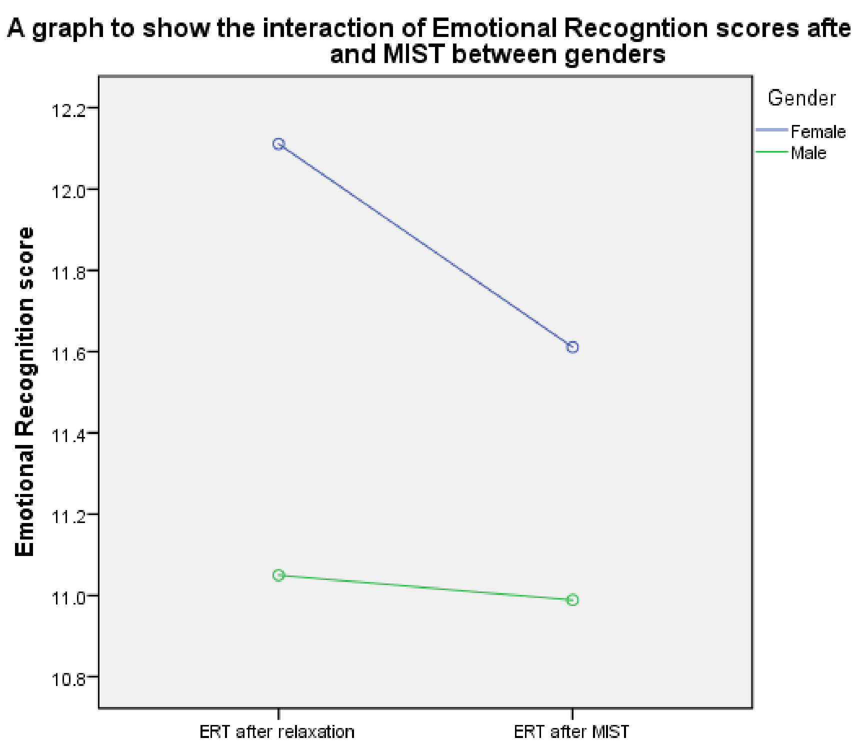
The total of correctly identified emotions after relaxation and MIST task for each participant was calculated. A two –way repeated measures ANOVA was run to determine the effect of stress on emotional recognition between genders, the effect of stress on emotional recognition in conditions A or B was also included in the analysis.

Mauchly's test of sphericity indicated that the assumption of sphericity was not met for the two- way interaction $\chi^2(2)$= .000, p = .000, Huynh- Feldt correction was made.

The ANOVA revealed that there was no statistical difference in condition by task interaction on emotional recognition accuracy, F (1,33)= 1.318, p= 0.259. There was no significant main effect for condition: participants taking part in condition A (M=11.139) did not score significantly higher than those taking part in condition B (M=11.742), F(1,33)= .2.057, p=.161

There was also no significant gender by task interaction on emotional recognition accuracy: F(1,33)= .562, p= 0.459. However the main effect of gender differences in emotional recognition accuracy indicated a strong tendency towards significance, with the mean ER score .842, 95% CI [-.013 to 1.697], higher in females compared to males, F (1, 33) 4.011, p=.053.

Graph 5.



And, there was no main effect of task: there was no significant difference between emotional recognition scores after relaxation (*M*=11.581) and after MIST (*M*=11.00), *F* (1,33) =.918, *p*=.345.

An independent T test was carried out to further explore the gender differences in emotional recognition. There was homogeneity of variances for emotional recognition score for males and females after relaxation, assessed by Levene's test for equality of variances (*p*=.371) and after MIST task (*p*=.476). Female emotional recognition score (M=12.11, SD=1.410) was higher than male emotional recognition score (M=11.05, SD=11.05) after relaxation, indicating a statistically significant difference, *M*= 1.058, 95% CI [.007 to 2.110], *t*(35)= 2.044, *p*= .048, *d*=0.63.There was no significant difference between female emotional recognition score (M=11.61, SD=1.685) and male emotional recognition score (M=11.00, SD=1.491) after MIST task.

The total of correctly identified emotions of the unambiguous (easy) facial expressions and ambiguous (difficult) micro expressions after relaxation and MIST task for each participant were also calculated. A two –way repeated measures ANOVA was run to determine the effect of stress on emotional recognition of unambiguous and ambiguous facial expressions between genders, the effect of stress on emotional recognition in conditions A or B was also included in the analysis.

Unambiguous facial expressions

Mauchly's test of sphericity indicated that the assumption of sphericity was not met for the two- way interaction $\chi^2(2)$= .000, *p* = .000, Huynh- Feldt correction was made. The ANOVA revealed that there was no statistical significant condition by task interaction on emotional recognition accuracy of easy facial expressions, *F* (1,33)= .787, *p*= .382. There was no significant main effect for condition: participants taking part in condition A (*M*=8.250) did not score significantly higher than those taking part in condition B (*M*=8.558), *F*(1,33)= .816, *p*=.373.

There was also no statistical significant gender by task interaction on emotional recognition accuracy of easy facial expressions, *F* (1,33) =.366, *p*=.549.There was a statistically significant main effect of gender: Females (*M*=8.889) scored significantly higher than males (*M*=7.919), *F* (1,33)= 8.064, *p*=.008. And, there was no main effect of task: there was no significant difference between emotional recognition scores after relaxation (*M*=8.344) and after MIST (*M*=8.464), *F* (1,33) =.366, *p*=.549.

Ambiguous facial expressions

Mauchly's test of sphericity indicated that the assumption of sphericity was not met for the two- way interaction $\chi^2(2)$= .000, *p* = .000, Huynh- Feldt correction was made. The ANOVA revealed that there was no statistical significant condition by task interaction on emotional recognition accuracy of difficult facial expressions, *F* (1,33)= 2.604, *p*= .116.

There was no significant main effect for condition: participants taking part in condition A (*M*=2.917) did not score significantly higher than those taking part in condition B (*M*=3.108), *F*(1,33)=.255, *p*=.617.

There was also no statistical significant gender by task interaction on emotional recognition accuracy of difficult facial expressions, *F* (1,33) =.366, *p*=.549. Also, there was no significant main effect for gender: Females (*M*=3.028) did not score significantly different than males (*M*=2.997), *F* (1,33)=.006, *p*=.936. Additionly, there was no main effect of task: there was no significant difference between emotional recognition scores after relaxation (*M*=2.944) and after MIST (*M*=3.081),*F* (1,33) = .526, *p*=.473.

Discussion

The current study aimed to investigate gender differences in the effect of stress on emotional recognition in participants taking part in higher education. Stress was induced using the MIST based task, to measure stress response both subjective measure and physiological measure, EDA. Both measures confirmed stress was induced during the MIST task and all participants remained stressed during the emotional recognition task after completing the MIST task.

The hypothesis that a gender difference will be found in the effect of social stress on emotional recognition is not supported by the results. The results revealed that there was no significant gender by task interaction on emotional recognition, therefore the hypothesis is rejected. This was also concluded for emotional recognition of ambiguous and unambiguous facial expressions. This suggests that under stress males and females' performance in emotional recognition follows a similar pattern. In terms of simple main effects, it was found that gender differences created a strong tendency towards a significant main effect on emotional recognition accuracy. This was also found for unambiguous facial expressions, however for ambiguous facial expressions a significant main effect of gender was not found, this could relate to the difficulty of identifying the micro expressions. To determine the nature of the identified effect of gender overall, further exploration of results found that females scored significantly higher than males after relaxation with a medium effect size of gender but no significant difference was found after stress was induced. As both males and females performance in emotional recognition follows a similar pattern whilst experiencing social stress, that is it decreases, the latter findings suggests that it may have a greater impact on emotional recognition score in females.

A main effect of gender on EDA measures was found with males scores significantly higher than females, the interaction between EDA measures and gender was not significant implying that patterns of EDA measures were similar throughout the tasks with males and females. The interaction between subjective stress measures and gender was also not significant and there was no main effect of gender. The subjective stress scale required participants to have an insight into their own psychological state, Zell and Krizan (2014) propose that people have only moderate insight into their abilities.   The scale was also given following the emotional recognition tasks as it could not be indicated whilst completing the tasks; both points lead to a physiological measure i.e. EDA to be a more reliable measure of stress.

Participants took part in condition A or condition B, with regard to emotional recognition score there was no significant condition by task interaction and no main effect of condition on emotional recognition score. This also applied for emotional recognition scores of ambiguous and unambiguous facial expressions. There was no effect of condition on subjective stress measures but an interaction was found with condition and EDA, but no significant difference. Overall, being in condition A or B did not impact in the effect of stress on emotional recognition between genders.

Implications

Although, no significant interaction was found between gender and emotional recognition accuracy after relaxation and stress, the main effect of gender verged on significance. The finding that females scores for emotional recognition accuracy was significantly higher than males in relaxed ERT is consistent with previous research e.g. Wingenbach et al, 2018. This result was not transferred to the emotional recognition task that was carried out under stress; a new implication in research. This could explain why emotional recognition accuracy in men was significantly lower than females after relaxation but not after stress. Moreover, under social stress, a historical need for women to co-operate rather than jeopardize pregnancy or risk important relationship has been suggested, which could have led women to misidentify negative emotions as positive under stress (Taylor et al, 2000). This has been indicated in previous research investigating gender differences in pro-social behaviour, women were found to be more co-operative than males (Nickels et al, 2017).

With reference to the ERT under stress, no significant difference between males and females was found; caution should be applied to the face value of this result. Gender differences in behaviour response to stress in terms of ER has previously been neglected; previous research indicating sex differences in behavioural response to psychosocial stress may be due to the different behaviour investigated and cannot be generalised to that of emotion (Gonzalez-Liencres et al. 2016; Stroud et al. 2002.). In all, with reference to this finding it is important to consider the baseline differences between gender in ER and that the effect of psychosocial stress seemed to reduce these differences.

A main effect of gender was also found in EDA measurements, female physiological measurements of stress were significantly lower than male physiological measurements of stress. This is consistent with previous research studies that have induced psychosocial stress, men have been found to have a greater response on ACTH, serum cortisol, salivary cortisol and a higher HPAA response (Kajantie and Phillips 2006; Stephens et al, 2016;). Although, an interaction was not found between EDA measures and gender, suggesting that EDA was higher in males regardless of stress. Taking part in the experiment itself could have induced stress in participants, more so males, which could explain the significant difference in EDA measures even during relaxation. Stress differences in EDA were not transferable to subjective stress measures; this was also found by Stroud and collegues (2002), when investigating sex differences in stress response there was no differences in mood ratings but a greater physiological response in men. This suggests that differences in physiological stress measures may reflect implicit cognitive processes or biological processes rather than mediation of affect and perceptions of stress.

Biological localisation of function regarding emotion and decision-making has been reported as differing between genders, results of the current study imply that this does not influence differences in behavioural output concerning the effect of stress on ER (Cahill et al, 2004; Tranel et al, 2005). A condition that has influenced sex differences in behavioural output is right sided VMPC lesions, which led to severe deficits in emotional functioning, including emotional processing in men but not in women. By contrast, left sided lesions produced significant impairments in women (Tranel et al, 2005). Differences between genders in ER regardless of stress could be a cognitive style resulting from gender-related neurobiological differences, but it could be also argued that cognitive styles account for asymmetry of VMPC function. This could be explored further as a double dissociation is needed to infer further conclusions.

Furthermore, an aim of the study was to explore the effect of stress on emotional recognition; emotional recognition accuracy decreased in the ERT under stress but there was no significant difference compared to relaxed ERT. Daudelin-Peltier et al. (2017) found that psychosocial stress significantly decreased the recognition sensitivity of disgust but significantly increased the sensitivity of surprise in males. The study did not investigate emotional recognition in females but in males there was no significant difference in emotional recognition between control group and group that underwent the stress condition. This was also found in boys; emotional recognition did not differ between groups (Chen et al, 2014). This is replicated in the findings of the current study but confidence in this similarity should be met with caution due to experimental differences, in particular the presentation of emotions as pair wise continua rather than individual expressions. An explanation for the finding that social stress had no significant effect on emotional recognition from an evolutionary perspective, could be that maintaining the ability to identify and measure potential threats under altered conditions is essential for survival, as discussed (McEwen, 2007).

In terms of identifying adaptive coping mechanisms to stress and emotional perception that could be applied to patients with maladaptive responses to emotion stimuli, it may be beneficial to report that emotional recognition did decrease in both males and females under stress.The current study demonstrates the influence of altered psychological state affecting cognitive processing, also found in patients with depression and anxiety (Gotlib et al., 2004; Bradley et al., 2000). And it may be that certain psychological states can have a positive effect on emotional recognition and more so, inducing such states in patients could actually lead to a faster recovery in deficits.

Limitations

A limitation of the study is the chosen stimuli for the ambiguous facial expressions. The microexpressions were extracted from the SAMM data base (Davison et al. 2017); trained professionals can identify micro expressions but accuracy was very limited in participants and may have been too difficult to identify, therefore having an effect on results. Ambiguous expressions may only be useful for comparing identification of individual emotions. Also, previous studies have utilised the TSST as a stressor, however the current study used the MIST task. Although both MIST the TSST include a mathematical component, the anticipatory period and public speaking task in the TSST may have a different impact on stress.

Previous studies used still images as stimuli for emotional expressions (Chen al, 2014; Daudelin-Peltier et al, 2017), even though the current study used video stimuli to improve ecological validity, other factors of emotional recognition were still excluded. For example, when recognising emotion in real life situations other factors may contribute such as tone of voice and body language, which is hard to replicate in an experimental study (Kidwell and Hasford, 2014).

With respect to time constraints, the accuracy and identification of each emotion whilst relaxed or stressed was not explored, but could be included in future research and lead to more accurate comparisons with existing research on the effect of stress on ER. In relation to gender differences, the analysis of emotional recognition of individual emotions could provide a further insight into this, especially in relation to evolutionary theory. Saying this, correctly identifying emotion of others is important in our own decision making, an emphasis on differences in individual emotion sensitivity rather than accuracy can draw attention from this (Attwood et al., 2017). Understanding how different psychological states affect ER accuracy could be important in understanding deficits in emotional recognition associated with TBI and depression.

Finally, a G*power analysis was conducted to establish the suggested amount of participants required for the study design to produce statistically sound results; the output was 88 participants (Faul et al, 2009). The currently study recruited 41 participants, with 4 sets of data disregarded; future research should aim to increase the sample size.

Conclusions

To conclude, the current study has explored the gender differences in the effect of stress, emotional recognition and the interaction of stress on emotional recognition between genders. It has provided an insight into an area previously restricted to male analogy with interesting results showing that no gender difference was found in the effect of stress on emotional recognition. In light of future research it is important to note that the present study considers acute stress and not chronic stress, which may exhibit different results. Gender differences in the perception of individual emotions and different psychological states could provide a promising direction for the future.

References

Adolphs, R. (2002). Recognizing Emotion from Facial Expressions: Psychological and Neurological Mechanisms. Behavioral and Cognitive Neuroscience Reviews, 1(1), pp.21-62.

Atwood, S.A., Easey,E. K., Dalili,N. M., Skinner,L. A., Woods, A., Crick, L., Ilett, E., Penton-Voak, S.I. and Munafo,R. M. (2017). State anxiety and emotional face recognition in healthy volunteers. *Royal Society Open Science*, 4(5) pp.605-611

Bradley B.P., Mogg K. and Millar N. (2000) Biases in overt and covert orienting to emotional facial expressions. *Cognition and Emotion*. 14, pp.789–808

Bechara, A., Damasio, H. and Damasio, A. ,R (2000). Emotion, Decision Making and the Orbitofrontal Cortex. *Cerebral Cortex,* 10(3), pp.295-307.

British Psychlogical Society (2010) *Code of Human Research Ethics*. Leicester: The

British Psychological Society

Cabello, R., Sorrel, M., Fernández-Pinto, I., Extremera, N. and Fernández-Berrocal, P. (2016). Age and gender differences in ability emotional intelligence in adults: A cross-sectional study. *Developmental Psychology*, 52(9) pp.1486-1492.

Cahill L, Uncapher M, Kilpatrick L, Alkire M, Turner J. (2004) Sex-related hemispheric lateralization of amygdala function in emotionally influenced memory: an fMRI investigation. *Learn Mem* , 11, pp. 261–6

Chen, F., Schmitz, J., Domes, G., Tuschen-Caffier, B. and Heinrichs, M. (2014). Effects of acute social stress on emotion processing in children. Psychoneuroendocrinology, 40, pp.91-95.

Collignon, O., Girard, S., Gosselin, F., Roy, S., SaintAmour, D., Lassonde, M., & Lepore, F. (2010). Audio-visual integration of emotion expression. *Brain Research*, 1242 pp. 126–135

Corbett, B., Weinberg, L., & Duarte, A. (2017). The Effect of Mild Acute Stress during Memory Consolidation on Emotional Recognition Memory. *Neurobiology of Learning and Memory,* 145, 34-44

Effects of Acute Psychosocial Stress on... (PDF Download Available). Available from: https://www.researchgate.net/publication/324085019_Effects_of_Acute_Psychosocial_Stress_on_Facial_Emotion_Recognition#pf8 [accessed Apr 17 2018].

Cusi, A. M., Nazarov, A., Holshausen, K., Macqueen, G. M., & McKinnon, M. C. (2012). Systematic Review of the Neural Basis of Social Cognition in Patients with Mood Disorders. Journal of Psychiatry and Neuroscience, 37 pp.154-169

Daudelin-Peltier, C., Forget, H., Blais, C. and Fiset, D. (2017). The effect of acute social stress on the recognition of facial expression of emotions. Scientific Reports, 7(1).

Davison, A. K., Lansley, C., Costen, N., & Yap, M. Y. (2017). SAMM: A Spontaneous Micro-Facial Movement Dataset. *ieee Transactions on affective computing.* 99, pp. 1-1

Dedovic, K., Renwick ,R., Mahani, N.K., Engert, V., Lupien,S. J. & Pruessner, J. C.(2005) 'The Montreal Imaging Stress Task: Using functional imaging to investigate the effects of perceiving and processing psychosocial stress in the human brain.' *Psychiatry Neurosci,* 30(5) pp. 319-25

Dedovic, K., Rexroth, M., Wolff, E., Duchesne, A., Scherling, C., Beaudry, T., Lue, S., Lord, C., Engert, V. and Pruessner, J. (2009). Neural correlates of processing stressful information: An event-related fMRI study. *Brain Research,* 1293, pp.49-60.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, pp. 1149-1160

Fernández, G., Hermans, E. J., Qin, S., &. van Marle, H. J. F (2009). From Specificity to Sensitivity: How Acute Stress Affects Amygdala Processing of Biologically Salient Stimuli. Biological Psychiatry, 66, pp.649-655

Gonzalez-Liencres, C., Breidenstein, A., Wolf, O. and Brüne, M. (2016). Sex-dependent effects of stress on brain correlates to empathy for pain. *International Journal of Psychophysiology*, 105, pp.47-56.

Gotlib, I. H., Krasnoperova, E., Yue, D. N., & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *Journal of Abnormal Psychology, 113,* 127–135

Gotlib, I., Joormann, J., Minor, K. and Hallmayer, J. (2008). HPA Axis Reactivity: A Mechanism Underlying the Associations Among 5-HTTLPR, Stress, and Depression. *Biological Psychiatry*, 63(9), pp.847-851.

Hampson, E., van Anders, S.M., & Mullin, L.I. (2006). A female advantage in the recognition of emotional facial expressions: Test of an evolutionary hypothesis. *Evolution and Human Behavior*, 27 pp. 407–416.

Ietswaart, M., Milders, M., Crawford, J.R., Currie, D., & Scott, C.L. (2008). Longitudinal aspects of emotion recognition in patients with traumatic brain injury. *Neuropsychologia*, 46(1) pp. 148–159

Imig, J., Erwin, R. and Turetsky, B. (2000). 543. Gender differences in emotional recognition and hemispheric asymmetry. Biological Psychiatry, 47(8), pp.165-178

Kajantie, E. and Phillips, D. (2006). The effects of sex and hormonal status on the physiological response to acute psychosocial stress. *Psychoneuroendocrinology,* 31(2), pp.151-178.

Kidwell, B. and Hasford, J. (2014). Emotional Ability and Nonverbal Communication. *Psychology & Marketing*, 31(7), pp.526-538

Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces* - KDEF, CD ROM from Department of Clinical Neuroscience, Psychology section, Karolinska Institutet, ISBN 91-630-7164-9.

McEwen, B. S. (2007). Physiology and Neurobiology of Stress and Adaptation: Central Role of the Brain. *Physiological Reviews,* 87 pp. 873-904.

Nickels, N., Kubicki, K. and Maestripieri, D. (2017). Sex Differences in the Effects of Psychosocial Stress on Cooperative and Prosocial Behavior: Evidence for 'Flight or Fight' in Males and 'Tend and Befriend' in Females. *Adaptive Human Behavior and Physiology,* 3(2), pp.171-183.

Neumann, D., Babbage, D., Zupan, B., & Willer, B. (2015). A randomized controlled trial of emotion recognition training after traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 30(3) pp. E12– E23.

Peirce, J. W. (2007) 'PsychoPy--Psychophysics software in Python.' *J Neurosci Methods*, 162(1-2) pp. 8-13.

Peirce, J. W. (2008) 'Generating Stimuli for Neuroscience Using PsychoPy.' *Front Neuroinform*, 2 p. 10.

Snowden, R., Craig, R. and Gray, N. (2013). Detection and recognition of emotional expressions: Effects of traits of personality disorder and gender. Personality and Individual Differences, 54(2) pp.158-163.

Stephens, M., Mahon, P., McCaul, M. and Wand, G. (2016). Hypothalamic–pituitary–adrenal axis response to acute psychosocial stress: Effects of biological sex and circulating sex hormones. *Psychoneuroendocrinology,* 66, pp.47-55.

Staal, M. A. (2004). *Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framewor*k. Moffett Field, CA: NASA Ames Research Center.

Stroud, L.R., Salovey, P. and Epel, E. S.(2002). Sex differences in stress responses: social rejection versus achievement stress. Biological Psychiatry, 52(4), pp.318-327.

Sulikowski, D. and Burke, D. (2014). Threat is in the Sex of the Beholder: Men Find Weapons Faster than do Women. Evolutionary Psychology, 12(5) pp.913-931

Taylor, S., Klein, L., Lewis, B., Gruenewald, T., Gurung, R. and Updegraff, J. (2000). Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *Psychological Review*, 107(3), pp.411-429.

Tranel, D., Damasio, H., Denburg, N. and Bechara, A. (2005). Does gender play a role in functional asymmetry of ventromedial prefrontal cortex?*. Brain*, 128(12), pp.2872-2881.

Von Dawans, B., Fischbacher, U., Kirschbaum, C., Fehr, E. and Heinrichs, M. (2012). The Social Dimension of Stress Reactivity. Psychological Science, 23(6), pp. 651-660

Wieser, M. J., Pauli, P., Reicherts, P and Muhlberger, A (2010) Don't look at me in anger! Enhanced processing of angry faces in anticipation of public speaking. Psychophysiology, 47(2), pp. 271-280.

Wingenbach, T., Ashwin, C. and Brosnan, M. (2018). Sex differences in facial emotion recognition across varying expression intensity levels from videos. PLOS ONE, 13(1), p.e0190634.

Wright, R., Riedel, R., Sechrest, L., Lane, R. and Smith, R. (2017). Sex differences in emotion recognition ability: The mediating role of trait emotional awareness. Motivation and Emotion, 42(1), pp.149-160.

Zell, E. and Krizan, Z. (2014). Do People Have Insight Into Their Abilities? A Metasynthesis. *Perspectives on Psychological Science,* 9(2), pp.111-125.

Zupan, B., Babbage, D., Neumann, D. and Willer, B. (2017) Sex differences in Emotion Recognition and Emotional Inferencing Following Severe Traumatic Brain Injury. *Disorders of Social Cognition; Advances in Theory, Assessment and Treatment*. 18 (1), pp. 36-48